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7. AUTHOR(s) John J. Williams, P.E.		6. PERFORMING ORG. REPORT NUMBER
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization. Merriman Dam was found to be in excellent condition.		

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HUDSON RIVER VALLEY
ROUNDOUT CREEK, ULSTER COUNTY
NEW YORK

MERRIMAN DAM

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM.

Merriman Dam (NY 00121). Hudson River Valley, Roundout Creek, Ulster County, New York. Phase I Inspection Report.

NY 00121

11 Aug 78

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DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
26 FEDERAL PLAZA

NEW YORK, NEW YORK 10007
AUGUST 1978

New York State Dept of
Environmental Conservation

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HUDSON RIVER BASIN

Name of Dam: Merriman Dam
County and State: Ulster County, State of New York
Inventory Number: NY 00121

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared by: O'Brien and Gere Engineers, Inc.

For: New York State
Department of Environmental Conservation

Date: July 27, 1978

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Merriman Dam

State Located: New York

County Located: Ulster County

Stream: Rondout Creek

Date of Inspection: June 27, 1978

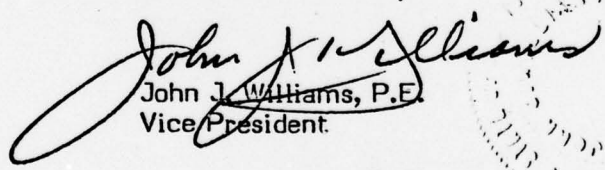
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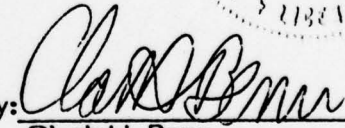
ASSESSMENT OF
GENERAL CONDITIONS

Merriman Dam and its appurtenances appear to be in excellent condition. The reservoir area, dam, spillway, tunnel and outlet works are well maintained.

The spillway is adequate to pass flood flows equal to the Probable Maximum Flood with approximately 9.0 feet of freeboard still available below the top of the dam.

O'BRIEN & GERE ENGINEERS, INC.


John J. Williams, P.E.
Vice President

Approved by: 

Clark H. Benn
Colonel, Corps of Engineers
District Engineer

Date: 21 September 1978

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UPSTREAM FACE OF DAM



UPSTREAM FACE OF DAM, SPILLWAY AND
RIGHT BANK OF RESERVOIR



SIDE CHANNEL AND SPILLWAY



VIEW OF SPILLWAY

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM MERRIMAN DAM ID# NY 00121

SECTION I - PROJECT INFORMATION

1.1 GENERAL

a. Authority - This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with contract #1467.021 between O'Brien and Gere Engineers, Inc., and the State of New York, Department of Environmental Conservation.

b. Purpose of Inspection - The purpose of this inspection is to evaluate the structural and hydraulic conditions of Merriman Dam and to determine if the dam constitutes a hazard to human life or property.

1.2 PROJECT DESCRIPTION

a. Description of Dam, Reservoir and Appurtenances (From information provided by the New York State Department of Environmental Conservation)

1. Dam and Reservoir - Merriman Dam (also known as Rondout or Lackawack Dam) is located in Ulster County, New York, approximately five (5) miles northwest of the community of Ellenville. The dam and reservoir, owned by the City of New York, are part of the "Delaware System" supplying water to New York City through the Delaware Aqueduct. Rondout Reservoir, placed in service in 1951, has a total available capacity of approximately fifty (50) billion gallons and a surface area at spillway crest of 2,080 acres. Its associated drainage area is 95 square miles. Merriman Dam, completed in 1945, is a "rolled earth embankment" approximately 2,400 feet long with a maximum height 195 feet above original ground. At its maximum section, the width of the dam is 60 feet at the top and 1,392 feet at the base.

The upstream face of the Dam has slopes varying from 1 (vertical) on $2\frac{1}{2}$ (horizontal) to 1 on 4. Three berms are provided at elevations 780, 725 and 712.5 respectively. The upstream face is protected by a "Rock Paving" on top of a graded layer of rock ("Rock embankment").

The downstream face of the dam is grass covered with slopes varying from 1 on 3 to 1 on 4. Three (3) berms are provided at elevations

←
[CONT'D ON
PAGE II]

712.5, 725 and 790 respectively. Longitudinal berm drains are provided with catch basins uniformly spaced.

A concrete cutoff wall is provided with a top elevation varying from approximately 850 to 710. The cutoff wall trench was excavated to "sound rock" and the cutoff wall was grouted in place.

2. Overflow Spillway and Channel - The overflow spillway and channel are constructed of large cut stones. The spillway (elevation 840) is 600 feet long. Water passes over the spillway onto a series of rock berms, then into a wide stone lined channel (see Photograph #A-11). This channel leads into a tunnel which discharges flow into Rondout Creek downstream of the dam. Flow in excess of the capacity of the tunnel is discharged by means of concrete lined channel (see Figure 6) located above the tunnel. This channel also discharges flow into Rondout Creek.

3. Outlet Works - Two (2) 54" steel pipes and four (4) 42" steel pipes are provided to allow water to pass from the reservoir into the Rondout West Branch Tunnel. The centerline of the pipe inlets is at elevation 697.5, 142.5 feet below spillway crest. Drawdown is also accomplished through these pipes. A weir is provided at elevation 720 just upstream of the inlets to the pipes

b. Size Classification - The normal storage volume of Rondout Reservoir is approximately 154,000 acre-feet. Since this exceeds 50,000 acre-feet, Merriman Dam is in the large size category as defined by the Recommended Guidelines for Safety Inspection of Dams.

c. Hazard Classification - The Village of Lackawack, population 500, is about 3/4 miles downstream of Merriman Dam. Therefore, failure of Merriman Dam could result in the loss of many lives and extensive damage to personal property. The structure is in the high hazard category as defined by the Recommended Guidelines for Safety Inspection of Dams.

1.3 PERTINENT DATA (From information provided by the New York State Department of Environmental Conservation)

a. Drainage Area - The drainage area of Rondout Reservoir is 95 square miles as stated in "Data Pertaining to N.Y. City Reservoirs" (see Figure #2).

b. Discharges - Maximum discharge through the outlet works with the reservoir at elevation 840, spillway crest, is 890 million gallons per day (1,377 cfs). Maximum discharge over the spillway is approximately 180,000 cfs.

c. Reservoir Data (@ Spillway Crest. Elevation 840)

Length - 6.5 miles
Average Width - 0.75 miles
Volume - 154,000 acre-feet
Length of Shoreline - 17.0 miles

d. Dam Data

Type - Rolled Earth Embankment
Top Elevation - 860 feet
Streambed Elevation @ Centerline of Dam - 665 feet
Length - 2,400 feet
Top Width - 60 feet
Bottom Width - 1,392 feet (at maximum section)
Side Slopes - 1 on 2.5, 1 on 3.5 and 1 on 4 (upstream face)
 ; 1 on 3 and 1 on 4 (downstream face)
Cutoff - Concrete cutoff wall as shown in Figure #5

e. Outlet Works - See Section 1.2 a-3.

f. Engineering Data - The information available for review of Merriman Dam included:

1. Contract and Specifications (contract 340) from the Board of Water Supply of the City of New York, dated 1939).
2. Contract drawings (contract 340) from the Board of Water Supply of the City of New York, dated 1939 and 1946.
3. Articles from "The Delaware Water Supply News" dated November 1, 1939, March 1, 1940, September 15, 1940, January 15, 1941, August 15, 1941, November 1, 1941, November 15, 1941.
4. Geologic Map of New York, Lower Hudson Sheet, 1961.
5. Information sheet entitled "Data Pertaining to New York City Reservoirs".

1.4 OPERATION AND MAINTENANCE - (From Contract Drawings dated 1939 & 1946 (Contract #340) provided by the Board of Water Supply, City of New York and from conversations with on-duty operation personnel)

Rondout Reservoir serves as part of the "Delaware System" for Water Supply for the City of New York.

a. Operation - Water passes from the reservoir into the Rondout "Effluent Chamber" through four (4) waterways. Within the "Effluent Chamber", the flow passes through two (2) 54" and four (4) 42" pipes. These pipes discharge flow into the Rondout-West Branch Tunnel which leads to New York City. The water is treated before it enters the tunnel.

Each of the four (4) inlet waterways is provided with screens to remove debris before flow enters the "Effluent Chamber." These screens are mechanically removable and are stored and maintained in the superstructure above the "Effluent Chamber." This superstructure also houses all controls for electrical operation of valves, overhead cranes, elevators, air compressors, heaters, etc.

b. Maintenance - Maintenance of all equipment and machinery is accomplished on a regular basis by assigned maintenance personnel. The operation and maintenance program is administered through the NYC regional office in Grahmsville, New York.

c. Flood Warning System - No flood warning system is in effect. However, an operator is on duty at the damsite 24 hours per day, every day.

SECTION 2 - VISUAL INSPECTION

2.1 FINDINGS

a. General - The field inspection of Merriman Dam and the Rondout Reservoir outlet works was accomplished on June 27, 1978. The reservoir water surface elevation was at 837, three (3) feet below the spillway crest. No underwater areas were inspected.

b. Outlet Works - The two (2) valve chambers for the two (2) 54" pipes and four (4) 42" pipes were inspected. The shafts leading to the chambers, the valve exteriors and the spaces below the valves for sump pumps appear to be maintained in excellent condition. Valves are operated electrically and are also equipped for manual operation. All equipment may be hoisted out of the valve chambers by means of an overhead crane. This crane and all other support equipment is housed in the outlet works building which also appears well maintained.

c. Downstream Face of Merriman Dam - The downstream face appears to be in excellent condition and is well maintained. A number of rodent holes, up to 2 feet in diameter, are evident on the downstream face of the embankment. Two sinkholes, one to three feet deep and approximately 10 feet in diameter, are evident approximately 100 yards downstream from the toe of the dam. The sinkholes were dry during the inspection.

d. Upstream Face - The "Rock Paving" on the upstream face is exposed and appears to be in excellent condition. Rectangular rocks, four (4) to five (5) feet on a side and approximately two (2) feet thick, make up most of the cover of the upstream face. Smaller rocks fill the voids between these larger rocks. An attempt was made to dislodge a few of these smaller rocks by hand. In all cases, this was impossible. Weathering was apparent on the surfaces of a few of the larger rocks.

e. Overflow Spillway and Channel - The overflow spillway, channel and entrance to the discharge tunnel were examined from the top of the dam. No water was flowing over the spillway; therefore, the entire overflow structure, up to and including the tunnel entrance, was visible. The spillway, downstream channel and tunnel entrance appear to be in excellent condition with virtually no deterioration visible. There is minor seepage through the spillway about six (6) feet below the crest of the weir at the eastern end. The channel was clear and free of sediment or debris.

f. Reservoir - The reservoir and its banks are owned by the City of New York and no construction is permitted within the property line. Therefore, the banks are heavily wooded to the shoreline and rise at approximately a 20% slope. There appears to be little erosion.

g. Downstream Channel - The overflow tunnel and channel lead into Rondout Creek which passes by the Village of Lackawack approximately 3/4 miles downstream of Merriman Dam.

SECTION 3 - HYDROLOGY/HYDRAULICS

The design flood used for Merriman Dam and Rondout Reservoir is the Probable Maximum Flood (PMF), according to the Recommended Guidelines for Safety Inspection of Dams. The PMF was derived from the adjusted 12 hour Probable Maximum Precipitation (PMP) and was routed through the reservoir using the U.S. Army Corps of Engineers computer program HEC-1. From this analysis, peak outflows and storages were determined for various percentages of the PMF. The routing analysis revealed that 23,645 acre-feet of water would be stored for the peak PMF outflow of 77,104 cfs. The storage input, as derived on sheet #A-16 in the appendix, shows that this storage corresponds to a reservoir elevation of 851.0, 11.0 feet above spillway crest and 9.0 feet below the top of the dam. Therefore, there is no danger of overtopping from a storm resulting in a flood equal to or less than the Probable Maximum Flood.

According to "The Delaware Water Supply News", March 1, 1940:

"The maximum flood peak of record in the Rondout is that of August, 1928, reaching 26,715 cubic feet per second, with an indicated occurrence of once in 55 years; 14,000 cubic feet per second and over had been observed to occur three times in 25 years".

If inflow to the reservoir is assumed as 2 cfs per square mile of drainage area, drawdown from spillway crest to elevation 720 would take place in approximately 69 days.

SECTION 4 - STRUCTURAL STABILITY

4.1 VISUAL OBSERVATIONS AND DATA REVIEW

Plans, specifications and construction history were reviewed; the documents appeared thorough and in accordance with the state of the art of the year 1939. No design calculations were made available.

If the problems caused by the burrowing rodents, previously discussed, are not resolved, reduction in cross-sectional area and possible piping may result.

The dam is equipped with a considerable number of settlement measurement pipes on both its upstream and downstream face. According to verbal information provided by on-site operators in the Operation and Maintenance Office for Merriman dam in Grahmsville, New York, these pipes were monitored daily during construction to identify embankment settlement. After construction, the pipes were checked frequently for a period of approximately ten (10) years. Throughout this entire period, no appreciable settlement was observed. These pipes are presently not monitored for settlement.

Articles from "The Delaware Water Supply News" were provided by the New York State, Department of Environmental Conservation describing various design and construction procedures for Merriman Dam. Among the items discussed and reviewed for this report were: Model Tests of the Diversion Tunnel and Spillway System, Caisson Cutoff Construction, Soil Testing, Grouting and Compaction.

4.2 GEOLOGY AND SEISMIC STABILITY

Merriman Dam is located in the southeastern section of the Catskill Mountain area within the Appalachian Uplands physiographic province. The dam and Rondout reservoir lie in moderate to rugged topography formed by dissection of the underlying nearly horizontal non-marine Devonian shale and sandstone formations and modified by Pleistocene glaciation. Foundation materials at the dam consist of thick, granular, glacial deposits which were treated during construction by cutoff walls to preclude undue seepage losses from the impounded reservoir.

No major fault or fault zones are known to exist near the dam or reservoir. The dam is located within Seismic Zone 1 of the Seismic Zone Map of Contiguous States, and it appears that static stability conditions are satisfactory. No earthquakes of any significant magnitude have been recorded within 50 miles of the dam or reservoir. Therefore it appears that seismic stability conditions are satisfactory.

SECTION 5 - ASSESSMENT/REMEDIAL MEASURES

5.1 ASSESSMENT

Merriman Dam and its appurtenances appear to be in excellent condition. The visual inspection indicated that the outlet works, valve chambers, overhead crane and all support equipment are well maintained.

The spillway is adequate to pass flood flows equal to the Probable Maximum Flood with approximately 9.0 feet of freeboard still available below the top of the dam.

Minor seepage through the eastern end of the spillway was observed but should not affect the structural stability of the spillway section.

The significance of the sinkholes, located approximately 100 yards downstream from the toe of the dam, could not be determined from field observation.

The animal burrows on the downstream slope may penetrate into the embankment a considerable distance which may reduce the embankment cross-sectional area and increase the potential for fines migration.

5.2 REMEDIAL MEASURES

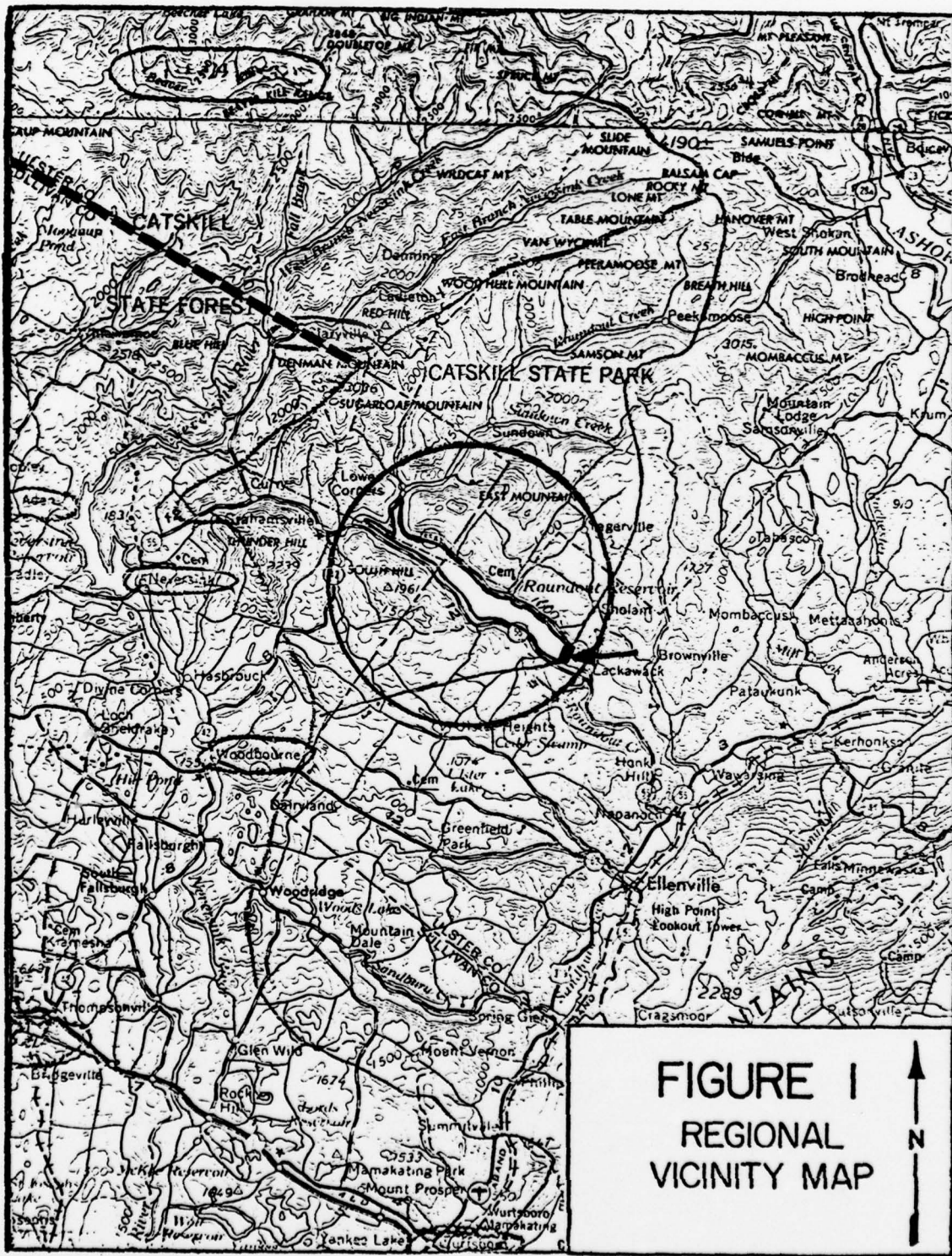
The following items are suggested as maintenance rather than emergency measures.

1. The sinkhole area, located approximately 100 yards downstream of the toe of the dam, should be monitored on at least a monthly basis to detect significant flow, fines migration, or the development of additional sinkholes.

2. Seepage through the eastern section of the spillway should be monitored; if the flow increases, remedial measures should be taken. A partial drawdown of the reservoir may be necessary to make the necessary repairs at the source of the flow.

3. Embankment settlement should be measured at least twice annually through the use of the settlement pipes and plates located on both the upstream and downstream faces of the dam.

FIGURES



CROTON SYSTEM

DATA PERTAINING

Name of Reservoir	Location		Drainage Area		Date Pu. Service	Kind of Dam
	Town	County	Sq. Mi.	Includes Items		
1 BOIES CORNERS	KENT	PUTNAM	22.46	1	1873	MASONRY, EARTH & LOG
2 BARRETT'S POND	"	"	0.3	2	1870	EARTH
3 LAKE GLENIDA	CARMEL	"	0.23	3	1870	EARTH
4 WEST BRANCH (Control)	"	"	42.27	1 to 4	1893	EARTH, MASONRY CORE & SPILLWAY
5 WEST BRANCH	"	"	"	"	"	"
6 MIDDLE BRANCH	SOUTHWEST	"	21.21	5	1875	EARTH, MASONRY CORE
7 BOB BROOK	"	"	3.87	6	1892	"
8 EAST BRANCH (BOON)	"	"	20.20	6 & 7	1891	MASONRY, EARTH & LOG
9 CROTON FALLS (SWEETING)	"	"	67.25	6 to 8	1911	EARTH, CONCRETE CORE & SPILLWAY
10 LAKE GLENDA	CARMEL	"	0.23	9	1870	EARTH
11 CROTON FALLS	"	"	68.24	9, 9.5, 9.10	1911	CYCLOPEAN MASONRY
12 LAKE KIRK	"	"	2.2	11	1870	EARTH
13 KATYHALL	BOONVILLE	ROSENBERG	19.15	10 to 12	1897	EARTH, MASONRY CORE
14 TITICUS	ROSENBERG	"	15.25	13	1893	MASONRY, EARTH & LOG & MASONRY
15 CROSS RIVER	ROSENBERG	"	2.25	14	1908	CYCLOPEAN MASONRY, CONCRETE
16 MUSCOOG	ROSENBERG & SUTTON	"	2.25	10 & 15	1905	MASONRY
17 NEW CROTON	CORLAND	"	2.25	1 to 16	1908	MASONRY
x Controlled Lakes			CROTON TOTALS			

CATSKILL SYSTEM

1 ASHOKAN	OLIVE BRIDGE - ULSTER	37.00	1	1925	MASONRY
2 SCHOMARIE	OLIVE BRIDGE - GREENE	3.4.00	2	1925	MASONRY
CATSKILL TOTALS					

DELAWARE SYSTEM

1 NEVERSINK	NEVERSINK	SULLIVAN	43.0	1	1933	EARTH, CONCRETE CORE
2 PEPACTON	COLEMAN'S LAKE & MIDDLETON	DELAWARE	372.0	2	1934	"
3 CANNONVILLE	DEPOT SPRINGS & WALTON	DELAWARE	4500	3	1937	ROLLED FILL
4 RONDOUT	NARROWS J. NEVERSINK	ULSTER SULLIVAN	43.0 10.0	1 to 4	1931	CONCRETE CORE
DELAWARE TOTALS						

KENSICO RESERVOIR & SAFETY

KENSICO	NEVERSINK	ULSTER	13.33	1935	MASONRY
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NG TO N.Y. CITY RESERVOIRS

THE IMPOUNDING RESERVOIRS BELONG TO THE CROTON, C
OPERATING LEVEL @ 560.0 ELEV. GAL. (AVAILABLE ABOVE 5

	Capacity (Bil. Gal.)		Area of water surface at Springway Elev.		Length of Shoreline Mi.'s	Elev. of Springway M.S.L. Sandy Hook Feet	Elev. of Ft. of Man. Dept. (Min. Oper. Line) Feet	Elev. of Sill or Outlet Feet	Depth to Outlet Feet	Dead Storage Billion Gallons	Levee Sp. Fee
	Total Area (Above Sill - Outlet)	1/2-1/2 Dept. (Min. Op. Line)	Sq. Mi.	Acres							
	1.096		0.464	296.9	6.2	560.05		538.7	43.4		1.25
	0.175		0.108	67.1	1.4	776.55		768.8	10.0		
	0.183		0.264	166.9	2.2	504.35		497.8	5.0		
	10.070		1.092	1002.0	15.6	508.2		488.8	47.0		280
	4.003		0.667	428.2	6.62	571.85	2	488.1			100
	4.400		0.840	549.0	4.9	418.35	0	383.1	37.5		
	5.353		0.698	558.8	10.5	418.35	4	381.8	65.0		500
	0.888		0.300	153.8	4.2	304.35	2	288.8	39.5		1000
	0.386		0.197	122.2	2.1	496.35	5	488.8	16.0		
	14.142		1.680	1062.4	18.0	304.3		248.8	45.0		700
	0.386		0.158	101.1	3.1	382.35		388.8	16.0		
	6.692		0.997	646.1	8.5	399.35		388.8	65.8		500
WBY CORN	7.187		1.046	669.4	8.7	324.3		394.8	75.0		250
78. PACES	10.306		1.202	784.2	12.9	324.35		288.8	105.0		240
	4.914		1.823	1166.1	35.0	190.35		187.8	30.0		450
	23.782		3.530	2294.2	35.0	195.35		187.8	35.0		1000
	94.637	66.6	15.531	9911.0	177.32						
	127.858	122.9	12.99	8315.2	40.2	195.35	UNKNOWN	288.8	35.75	4.137	980
	19.563	17.6	1.79	1145.0	16.5	1130.0	"	1080.0	80.00		1324
	147.447	140.5	14.75	9460.2	56.5						

W, CATTSKILL & DELAWARE SYSTEMS TOTALLING 547.6 BIL. GAL. ABOVE MIN.
 VE SILL. AN ADDITIONAL 30.6 BILL GAL. IS STORED IN A SAFETY STORAGE RES. KENSICO

Length of Spillway Feet	Max Depth Below Spillway Feet	Max Hgt of Main Dam		Width of Dam Feet		Length of Dam Feet	
		Above Lowest Foundation Feet	Above Normal Surface Feet	Top	Botl.	Total	Masonry Portion
125.0		78.0	97.0	6.60	53.60	670.0	670.0
280.0	NONE	66.0	82.0	18.00	307.00	1794.0	280.0
100.0		89.0	80.0	28.00	240.00	741.0	
100.0		94.0		30.00	680.00	815.0	100.0
		107.0	83.8	73.28	173.28	1532.8	
500.0		96.0	78.0	12.00	83.00	1100.0	500.0
600.0		81.0	48.0	18.00	270.00	2190.0	1000.0
700.0		173.0	113.0	28.00	118.00	1300.0	1100.0
30.0			88.0	28.00	654.00	1270.0	30.0
250.0		128.0	104.0	20.70	123.70	1817.0	250.0
240.0		170.0	126.0	23.00	118.00	1000.0	240.0
950.0		28.0		4.00	40.00	1130.0	1130.0
680.0		247.0	174.0	18.00	208.00	2185.0	2185.0

REMARKS

Most of the Croton Supply
 carried by the New Croton
 Aqueduct

930.0	150.0	292.0	210.0	26.33	300.00	4690.0	1000.0
324.0	180.0	182.0	155.0	15.00	138.00	2260.0	2000.0

Schoharie water is conveyed
 Tunnel to Adirondack Res. Th
 enter the Catskill Aqueduct

600.0	175.00	345.0	195.0	60.00	1392.00	2620.0	NONE
300.0	180.00	304.0	204.0	60.00	1180.00	2450.0	"
240.0	78.00	196.0	179.0	45.00	1312.00	2000.0	"
580.0	175.00	375.0	195.0	60.00	1392.00	2400.0	"

Neversink, Pepacton & Ca
 are conveyed via the Nev
 & W. Delaware Tunnels to
 thence all four supplies

SOME OF THE CROTON SUPPLY (SEE REMARKS).

60.0	155.60	307.0	166.0	28.00	235.00	1643.0	1048.0
------	--------	-------	-------	-------	--------	--------	--------

Of the Croton Supply, all
 plus pumpage from Cr
 Falls flows into Kensico

Summary
 J.M.

5 B/L. GAL. ABOVE MIN.
 A SAFETY STORAGE RES. KENSICO

Camp J.J.D.
 Crown J.R.D.

Length of Dam Feet	
al	Masonry Portion
0.0	650.0
1.0	240.0
2.0	100.0
3.0	
4.0	500.0
5.0	1000.0
6.0	1100.0
7.0	20.0
8.0	524.0
9.0	840.0
10.0	1130.0
11.0	2100.0

REMARKS

Most of the Croton Supply is
 carried by the New Croton
 Aqueduct

0.0	1000.0
1.0	2000.0

Schoharie water is conveyed by the Schoharie
 Tunnel to Adirondack Res. Thence both supplies
 enter the Catskill Aqueduct.

0.0	NONE
1.0	"
2.0	"
3.0	"

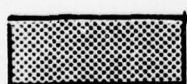
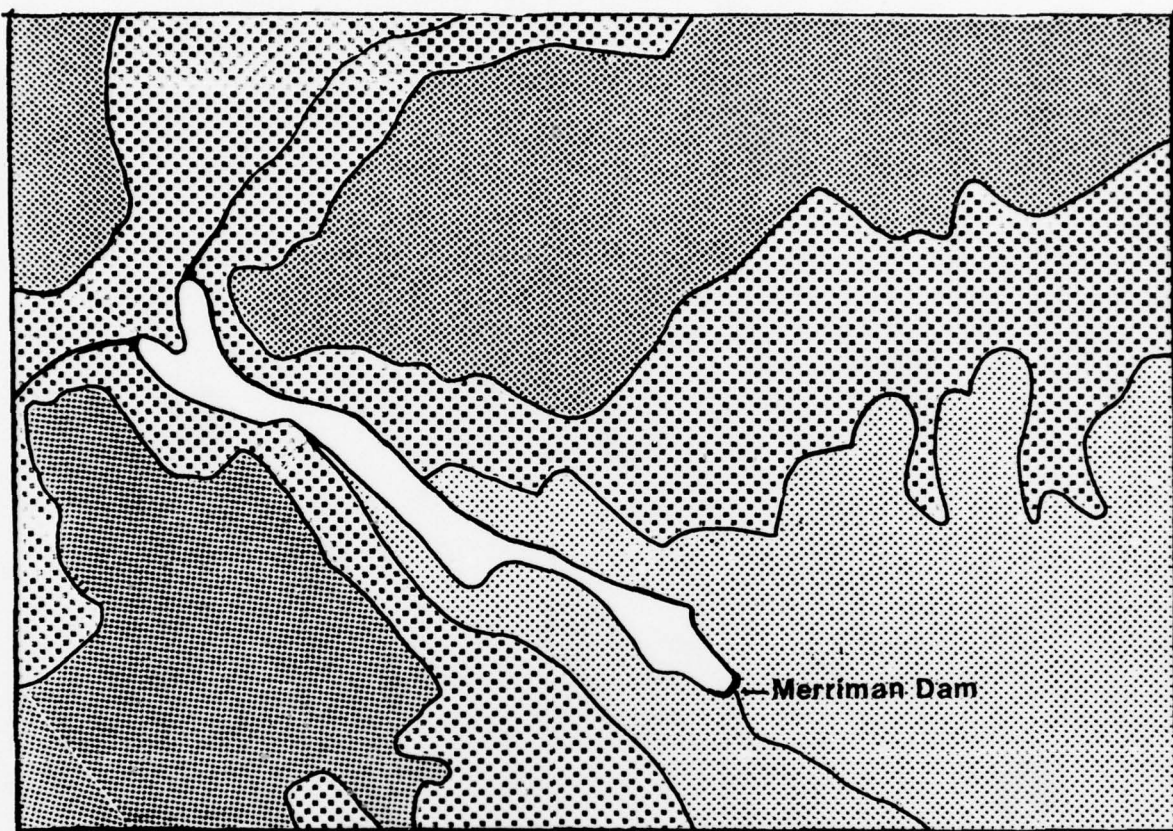
Neversink, Pepacton & Cannonsville supplies
 are conveyed via the Neversink, East Delaware
 & W. Delaware Tunnels to the Rondout Res.
 Thence all four supplies enter the Del. Aqueduct.

FIGURE 2

0	1043.0
---	--------

Of the Croton Supply, all of the West Branch
 plus pumpage from Cross River & Croton
 Falls flows into Kensico Reservoir.

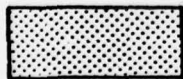
Acc 43



Dsd - sandstone, red shale and siltstone

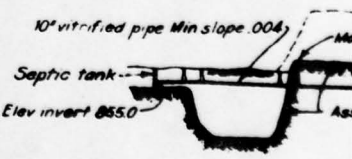
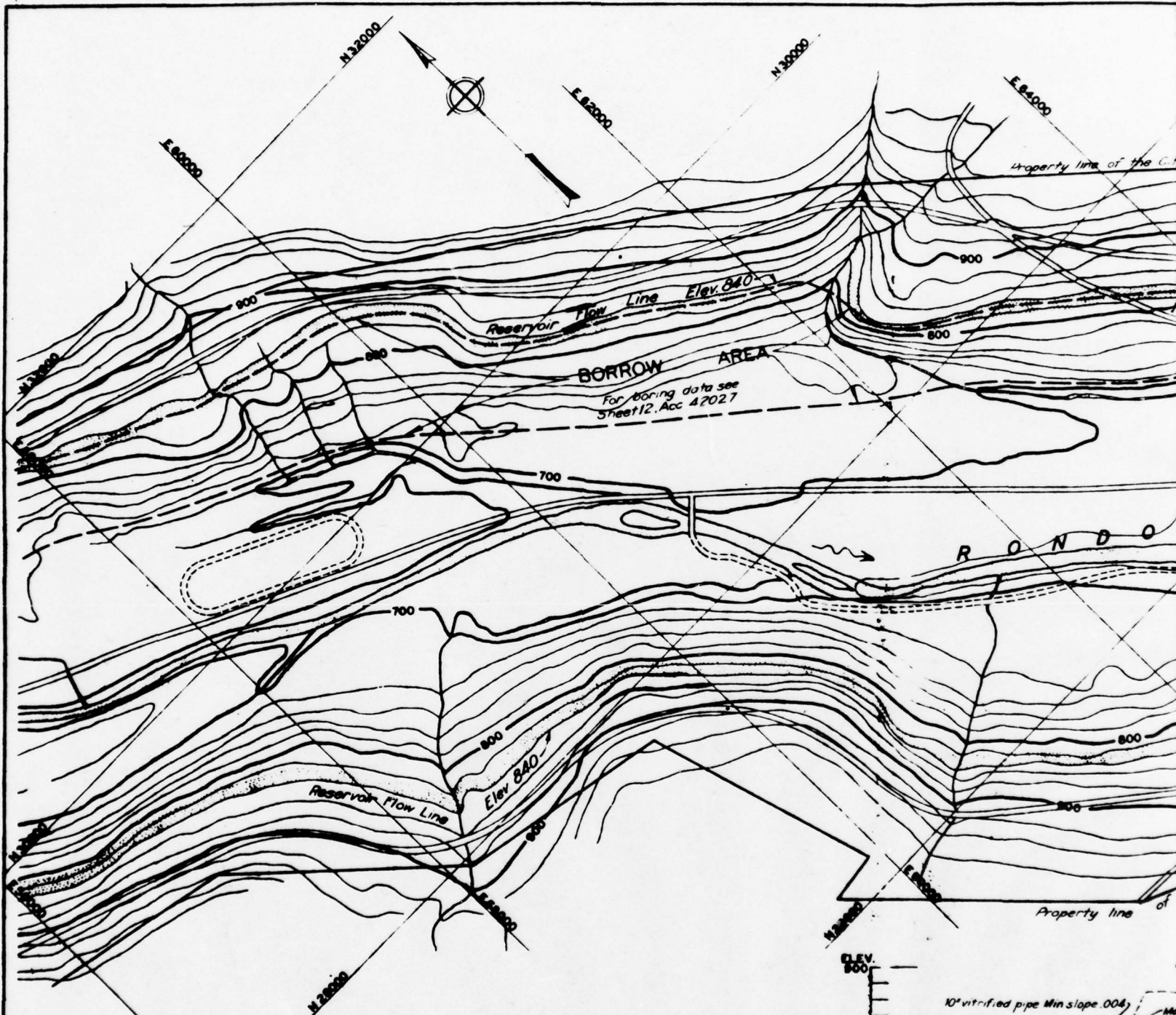


Dss - sandstone, conglomerate and shale



Dgk - sandstone and red shale

FIGURE 3
GEOLOGIC MAP



PROFILE OF SEW

Drawn: H.B.B.
 Revised: F.B.E.
 Checked: H.B.B.
 L. S. Carter
 Designing Eng.

Ref: Acc 42027-4

1

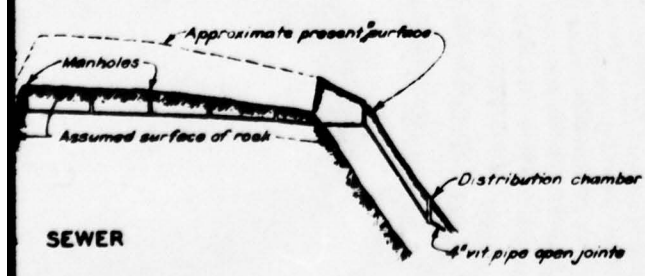
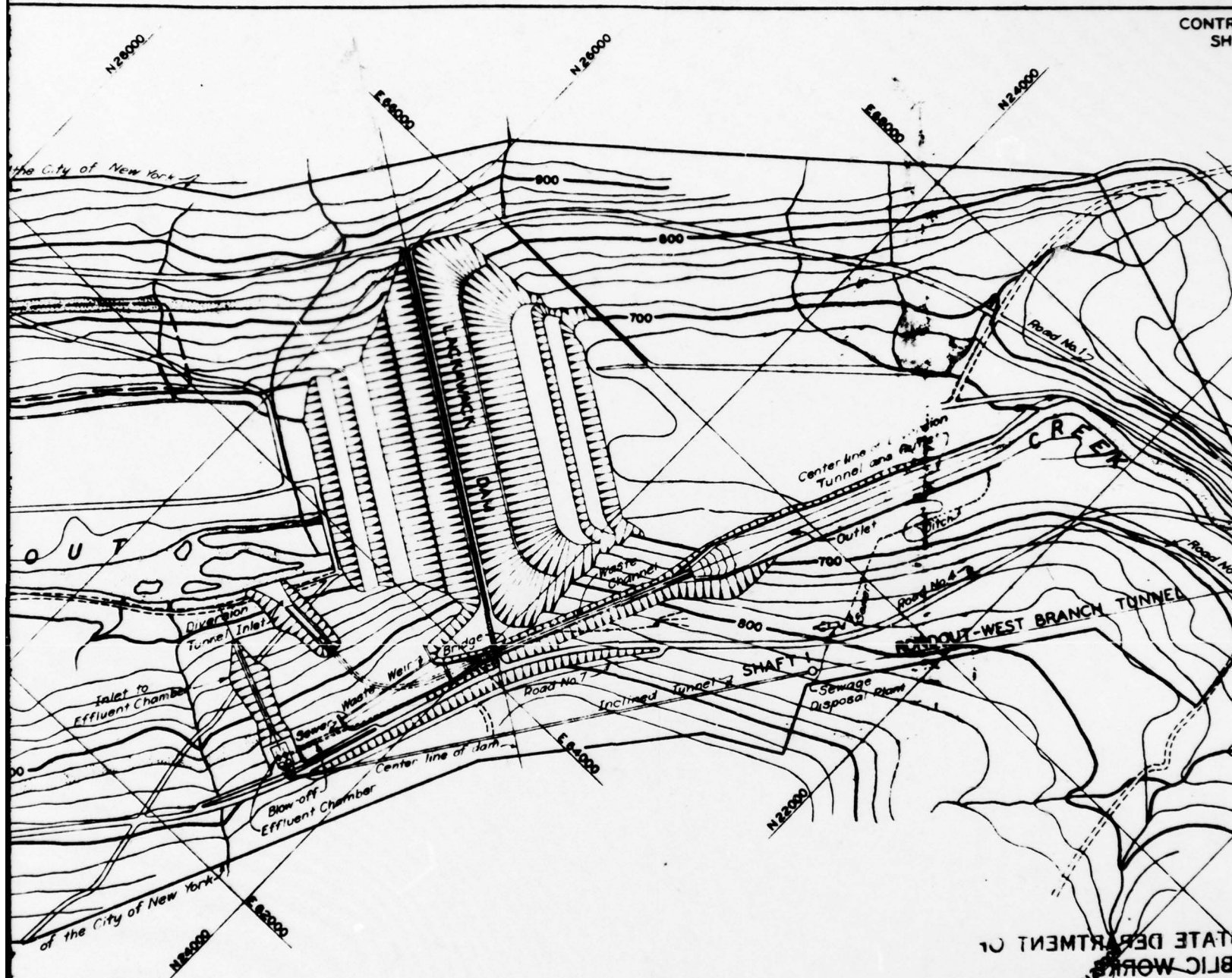


FIGURE 4

Rega St. Association
 Dept. Eng. Hdgrs.

STATE DEPARTMENT OF
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 OF ENGINEERING
 JUN 1 1938
 RECEIVED
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 CHIEF ENGINEER
 JAMES I. 1938
 FILED



Page St. Accounting
Dept Eng Hldrs

NEW YORK STATE DEPARTMENT OF
PUBLIC WORKS
DIVISION OF ENGINEERING
ALBANY, N. Y.

THIS PLAN FOR
CONSTRUCTING DAM NO. 1
WAS DESIGNED AND
APPROVED UNDER THE
PROVISIONS OF SECTION 948 OF THE
CONSERVATION LAW.

APPROVED
CITY OF NEW YORK

EXAMINED AND
APPROVED BY THE
STATE ENGINEER FOR
THE CITY OF NEW YORK

~~BLACKBARK DAM~~

PLAN NO. 1
APPROVED
APR. 1, 1938.

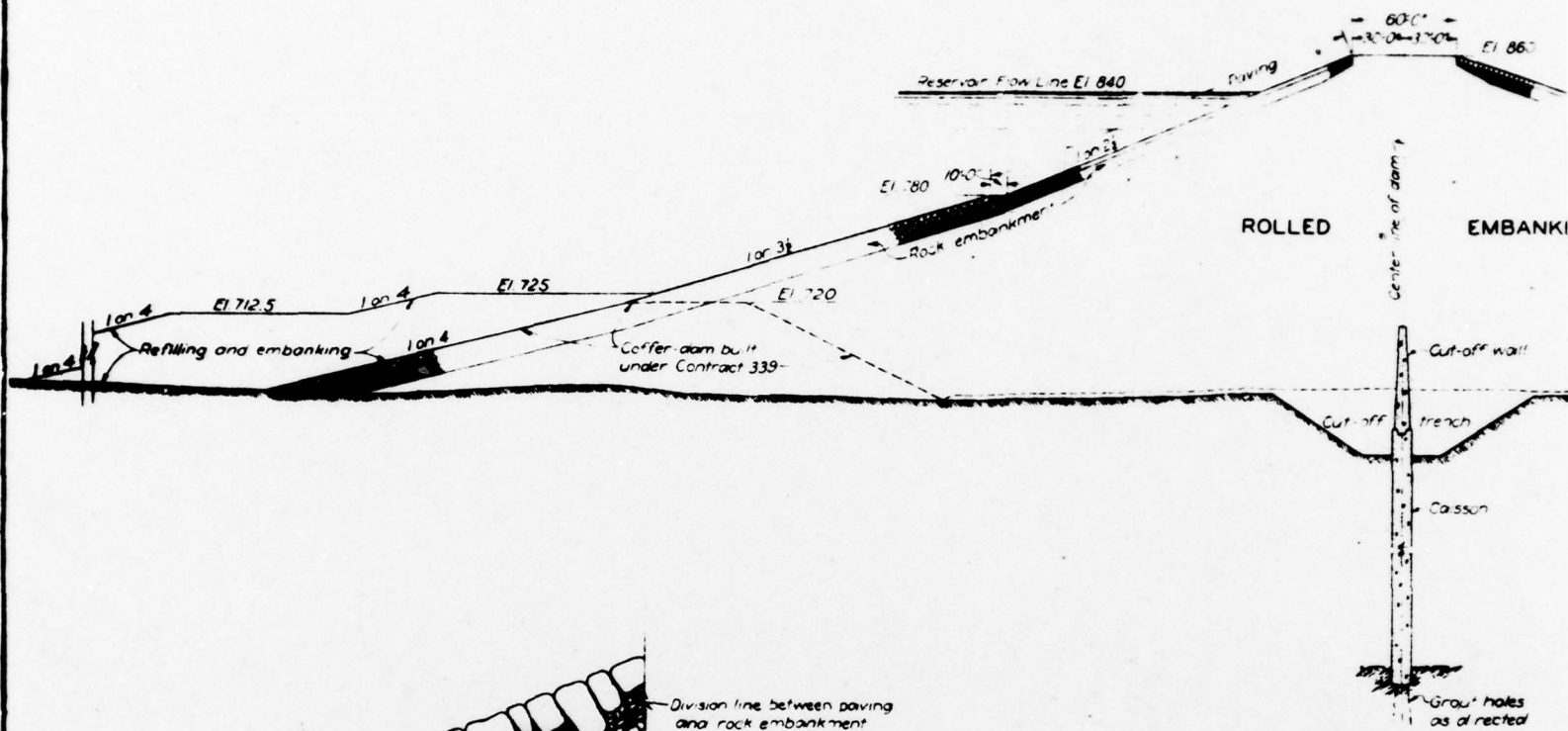
CHIEF ENGINEER
STATE OF NEW YORK
DEPARTMENT OF PUBLIC WORKS

File Cont. 340-3.4 RL Acc 40468

File Cont. 340 - 3.4 RL Acc AD482

2

43



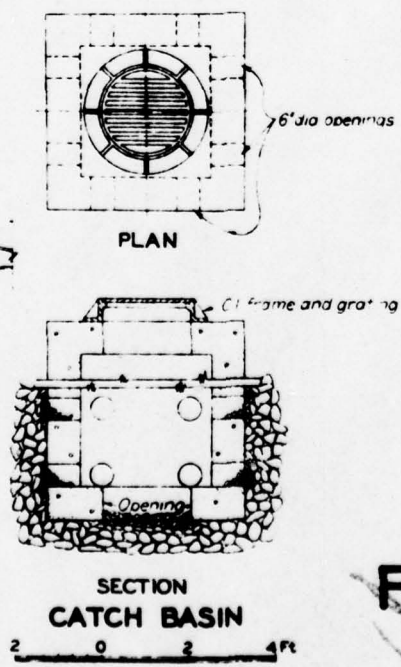
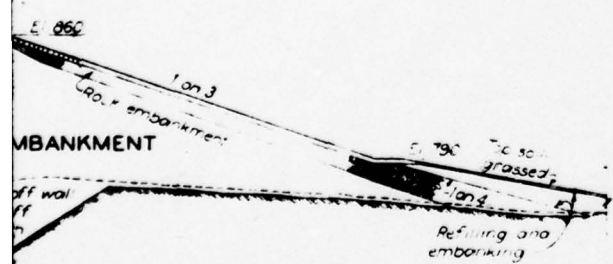
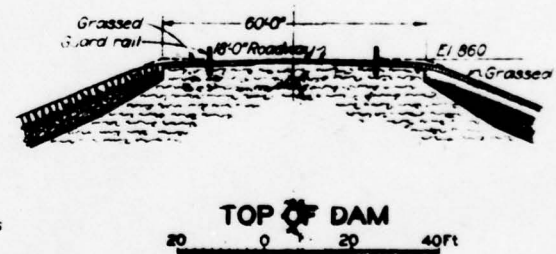
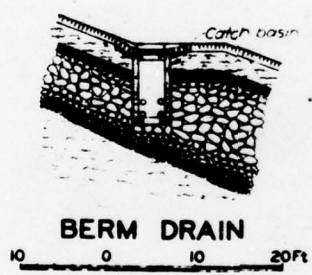
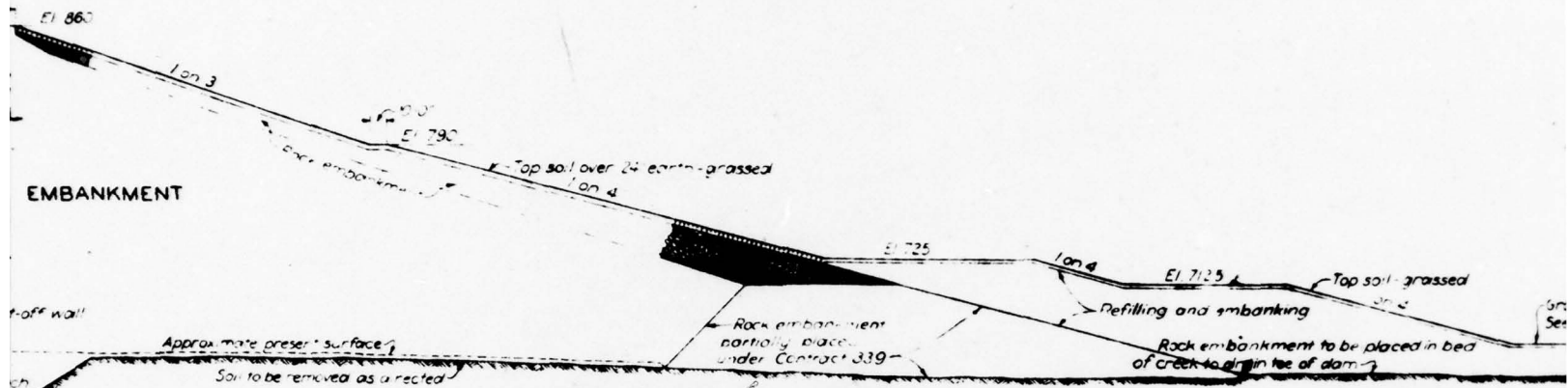
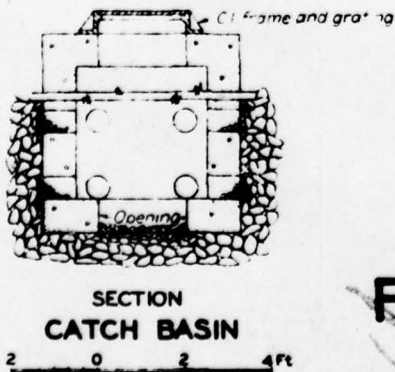
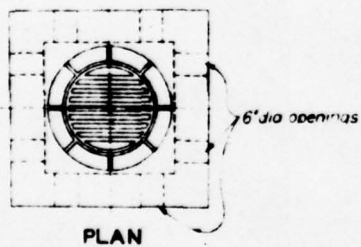
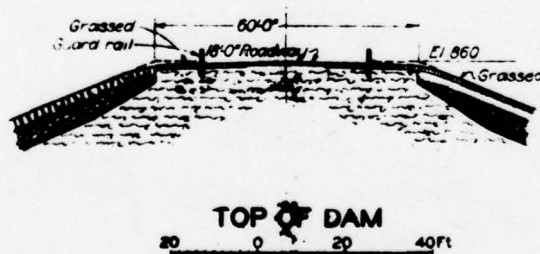
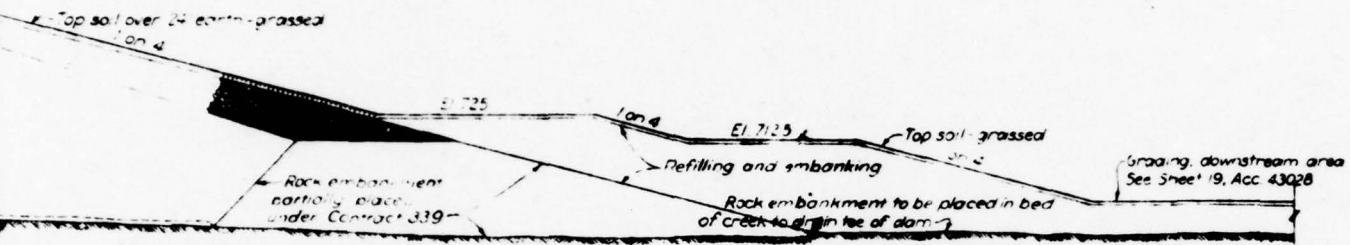


FIGURE 5

For plan
 For profile
 For details
 See also
 Acc 42254
 DEPARTMENT OF
 WORKS
 ENGINEERING
 Y. N. Y.
 including from New York
 watershed is hereby
 one of Section 948 of the
 Chief Engineer for
 LACKA
 CHIEF ENGINEER
 DEPT. OF ENVIRONMENTAL CONSERVATION
 STATE OF NEW YORK



For plan see Sheet 5, Acc. 42252
For profile see Sheet 6, Acc. 42037
For details of cut-off wall, trench and
coissons see Sheet 8, Acc. 42036, Sheet 9,
Acc. 42254, Sheet 10, Acc. 42256 and Sheet 11.

NEW YORK STATE DEPARTMENT OF
PUBLIC WORKS
DIVISION OF ENGINEERING
ALBANY, N. Y.

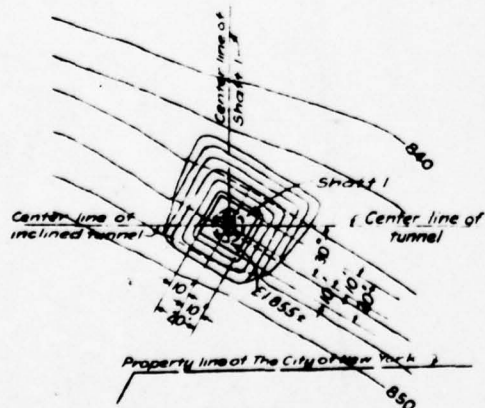
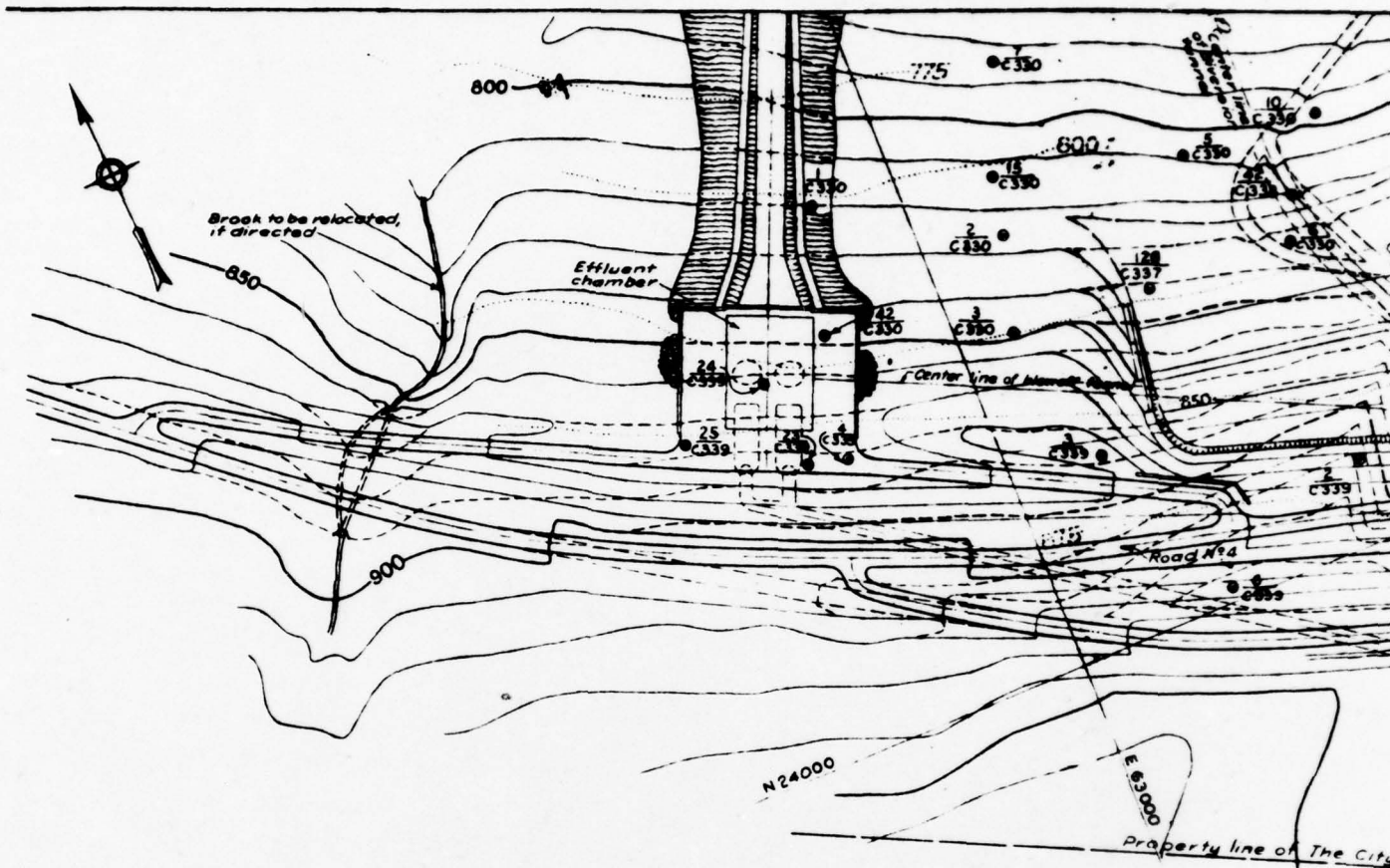
Approved for the provisions of Section 948 of the
Conservation Law, New York
City of New York
Examined and approved by the Chief Engineer for
ROCKAWAY DAM
ROCKAWAY DAM
ROCKAWAY DAM

FIGURE 5

APRIL 1, 1939
PROVED
CHIEF ENGINEER
File Cont. 340-34 RL
Acc. 42118

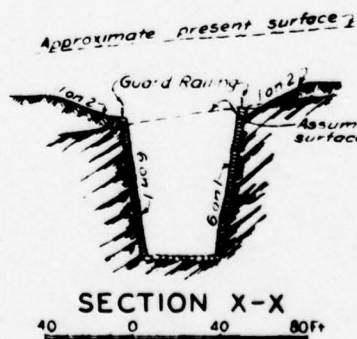
2

FIGURE 5 3



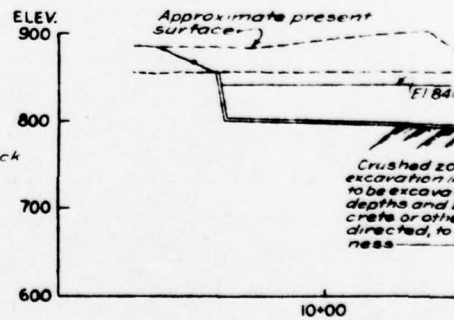
GRADING PLAN - SHAFT 1

1 40 0 40 80 Ft



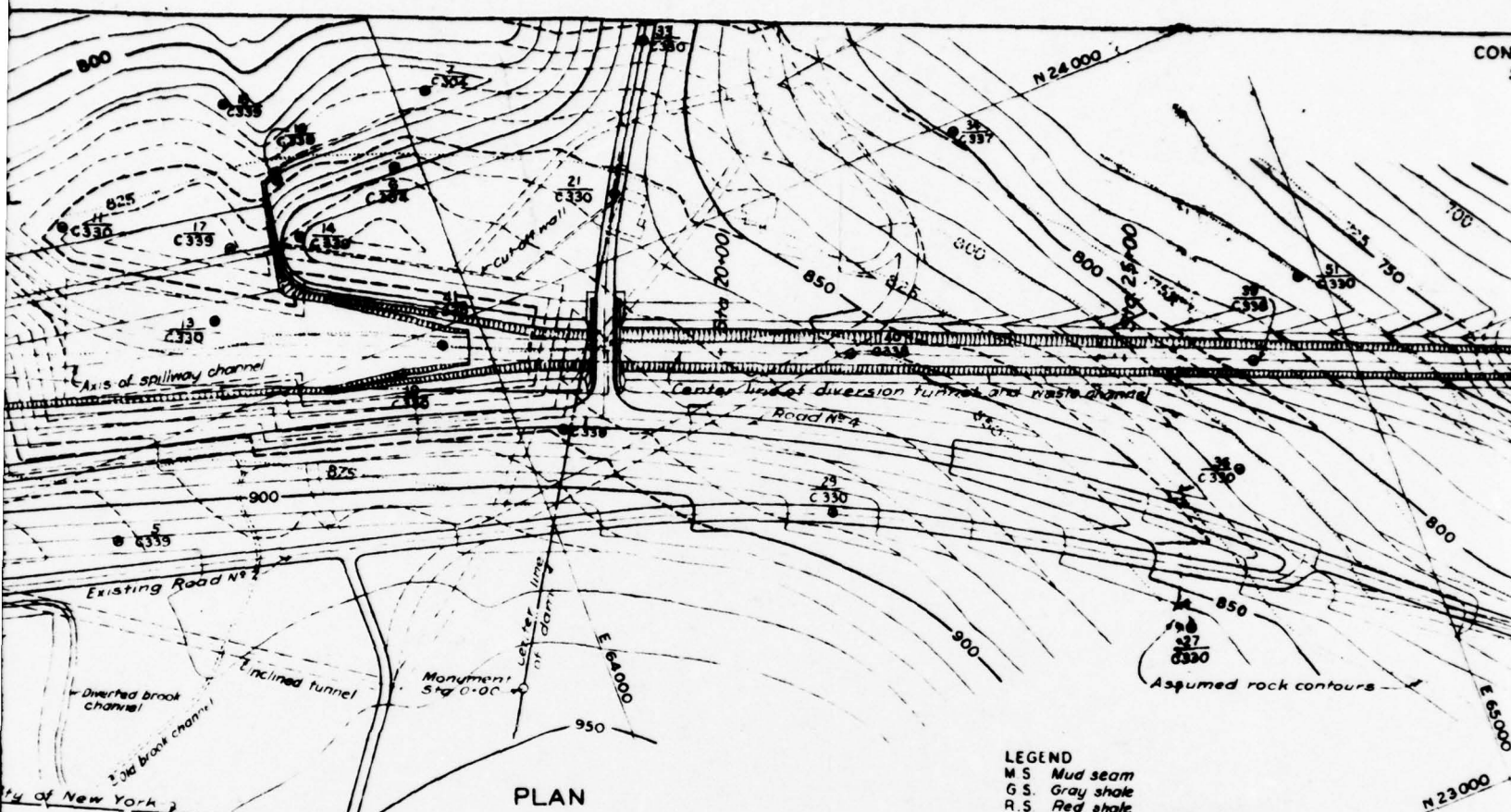
SECTION X-X

40 0 40 80 Ft



SECTION Y-Y

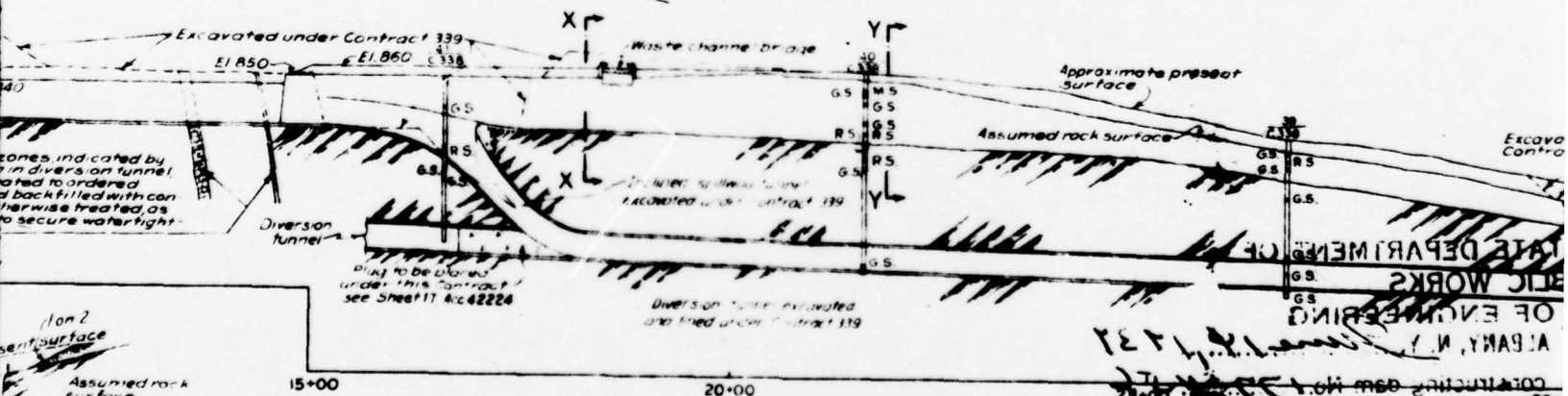
40 0 40 80 Ft



LEGEND

MS Mud seam
GS Gray shale
RS Red shale

Borings indicate fine to coarse grain sandstone or gray shale except as noted
Core boring records are available at the Engineers office, Lackawack, N.Y.



SECTION ON CENTER LINE

For plan and sections of Waste Weir and Channel see Sheet 14, Acc 42301 and Sheet 15, Acc 42279
For Highways, Plan and Profiles, see Sheet 16, Acc 43201

FIGURE 6

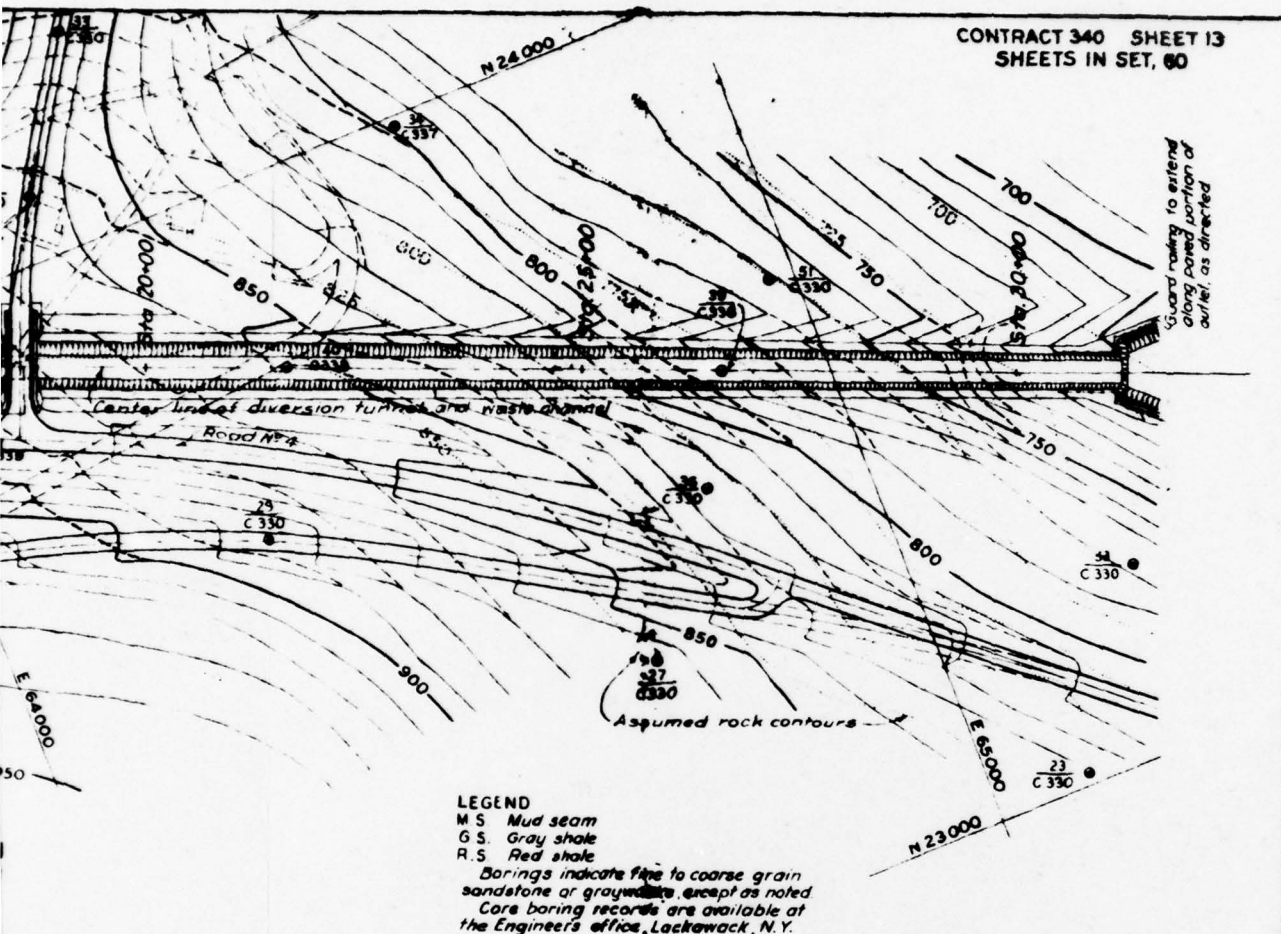
Robert H. Armstrong

CHIEF ENGINEER

Chief Engineer of the City of New York

2

CONTRACT 340 SHEET 13
SHEETS IN SET, 80



LEGEND

M.S. Mud seam
G.S. Gray shale
R.S. Red shale

Borings indicate fine to coarse grain sandstone or gray shale, except as noted.
Core boring records are available at the Engineer's office, Lackawack, N.Y.

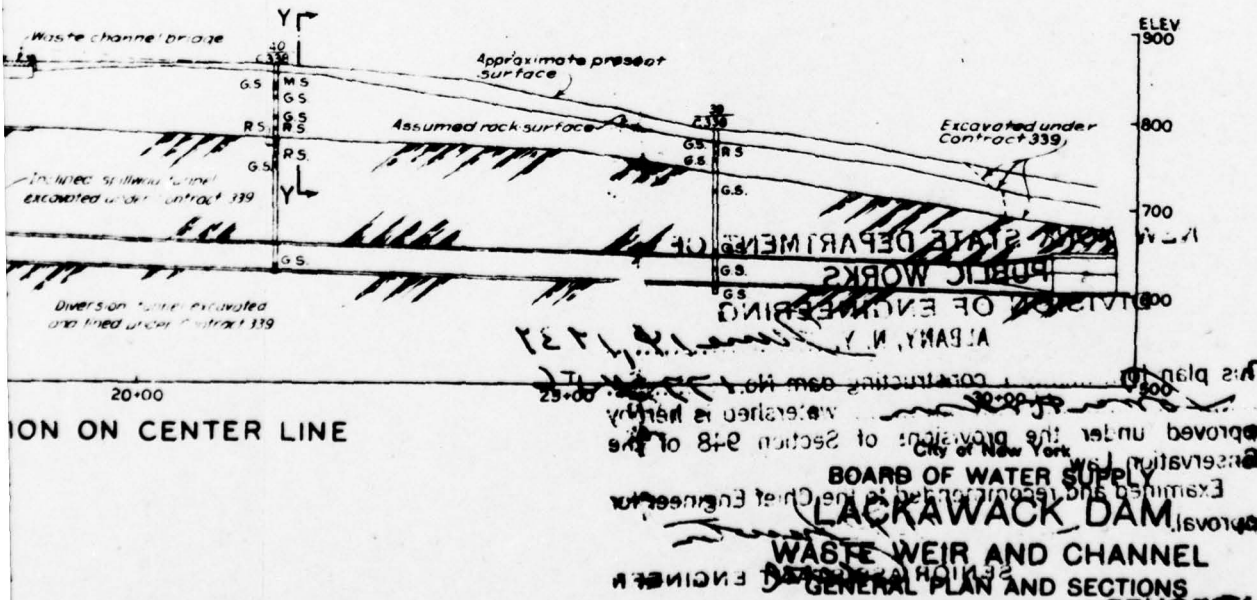


FIGURE 6

Reginald H. Armstrong

CHIEF ENGINEER

APRIL 1, 1938

Dist. Eng. Hdqrs. New York State

File Cont 340-344 RL Acc 42262

13

APPENDIX

FIELD INSPECTION REPORT

Check List
Visual Inspection
Phase 1

Name Dam Merriman Dam County Ulster County State New York Coordinators _____

Date(s) Inspection 6/27/78 Weather Sunny Temperature 90°

Pool Elevation at Time of Inspection 837 M.S.L. Tailwater at Time of Inspection 697.5 M.S.L.

Inspection Personnel:

A-1 George C. Elias, P.E.

James V. Ryan

Charles A. Richardson, P.E.

Frank E. Falcone, P.E.

Frank E. Falcone, P.E. Recorder

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	No cracks observed but downstream face shows a number of rodent holes.	Program should be implemented to remove the rodents and back-fill the holes.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	Approximately 100 yards downstream of the toe, two (2) sinkholes were observed. They were approximately 10' in diameter and 3' deep. At the time of inspection they were dry.	Steps should be taken to identify the reason for the sinkholes. Settlement pipes and plates should be monitored at least twice annually.
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	None observed.	None.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	In excellent condition.	None.
RIPRAP FAILURES	None.	None.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ADJUTENT, SPILLWAY AND DAM	Excellent condition.	None.
ANY NOTICEABLE SEEPAGE	None observed.	None.
STAFF GAGE AND RECORDER	Not observed.	None.
DRAINS	Longitudinal drains exist on the downstream face at the berms. Many catch basins were blocked by mowed grass.	Insure that catch basins are free of debris.

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	None, excellent condition.	None.
INTAKE STRUCTURE	Effluent chamber was inspected, excellent condition.	None.
OUTLET STRUCTURE A-4	Inspected areas were in excellent condition.	None.
OUTLET CHANNEL	Flow passes into Rondout-West Branch Tunnel, not inspected.	None.
EMERGENCY GATE	Not observed.	None.

INSTRUMENTATION

REMARKS OR RECOMMENDATIONS

VISUAL EXAMINATION

NONUMENTATION/SURVEYS

OBSERVATIONS

OBSERVATION WELLS

WEIRS

A-5

Weir at elevation 720 just upstream of pipe inlets, not observed.
(No underwater areas were inspected).

None.

PIEZONETERS

OTHER

Settlement Pipes and Plates

Settlement pipes and plates are provided on both upstream and downstream faces, currently not used.

A program should be implemented whereby settlement is monitored on each settlement pipe at least twice annually.

RESERVOIR

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION OF

SLOPES

Heavily wooded, stable
and clear of debris.

None.

SEDIMENTATION

None observed.

None.

DOWNSTREAM CHANNEL

REMARKS OR RECOMMENDATIONS

OBSERVATIONS

VISUAL EXAMINATION OF

CONDITION

(OBSTRUCTIONS,
DEBRIS, ETC.)

Well-defined and stable, only
minimal debris.

None.

SLOPES

Well-defined.

None.

APPROXIMATE NO.
OF HOMES AND
POPULATION

Village of Lackawack is approximately
1.5 miles downstream of Merriman Dam;
approximately 20 structures and a
population of 300 to 500.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CUT STONE WEIR	Generally in excellent condition, minor seepage through the spillway approximately 6' below the crest near the eastern end.	Monitor seepage, insure that it does not increase. If increase occurs, make structural repairs.
APPROACH CHANNEL	Excellent condition.	None.
DISCHARGE CHANNEL A-8	Excellent condition. Well-maintained, free of debris, adequate to pass probable maximum flow.	None.
BRIDGE AND PIERS	None.	None.

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

ITEM	REMARKS
PLAN OF DAM	* Provided in contract drawings, Contract #340, Board of Water Supply of the City of New York, dated 1939 and 1946.
REGIONAL VICINITY MAP	U. S. Geological Survey Quadrangles: 7.5 minute series, Rondout Reservoir; 15 minute series, Scranton, Pennsylvania, New York, New Jersey.
CONSTRUCTION HISTORY	Various articles from "The Delaware Water Supply News"
TYPICAL SECTIONS OF DAM	* Same.
HYDROLOGIC/HYDRAULIC DATA	None provided.
OUTLETS - PLAN	
- DETAILS	* Same.
-CONSTRAINTS	
-DISCHARGE RATINGS	
RAINFALL/RESERVOIR RECORDS	None provided.

REMARKS

ITEM

SPILLWAY PLAN

SECTIONS

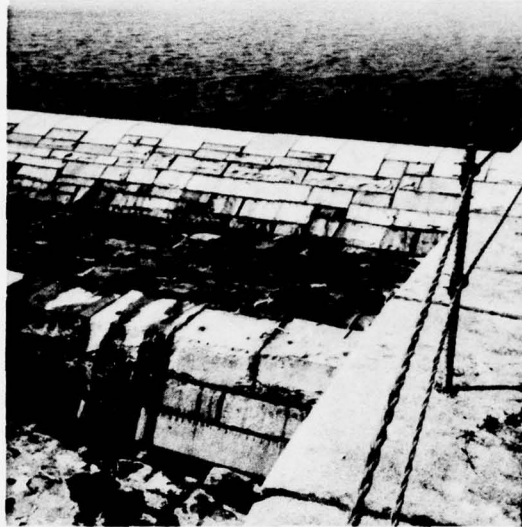
DETAILS

* Same.

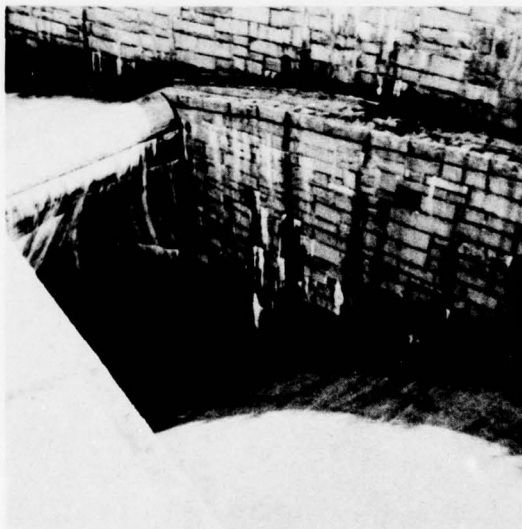
OPERATING EQUIPMENT
PLANS & DETAILS

* Same.

PHOTOGRAPHS



SPILLWAY SHOWING SEEPAGE



ENTRANCE TO TUNNEL AT DOWNSTREAM END OF CHANNEL

HYDROLOGIC AND HYDRAULIC CALCULATIONS

SHEET No. 1 OF

DATE 7/6/78

COMP. BY FEF

CHECKED BY DRC

NAME OF CLIENT _____

PROJECT MERRIMAN DAM

SPACE-CHARGE RELATIONS^{1,2}

$Q = CLH^{3/2}$ (spillway crest).

$$\left. \begin{array}{l} C = 3.4 \\ L = 600' \end{array} \right\} CL = 2040$$

1.	ELEVATION	HEAD	H $\frac{1}{2}$	D, SCHARLES
	840.0	0	0	0
	840.5	0.5	0.35	714
	841.0	1.0	1.00	2040
	842.0	2.0	2.83	5773
	843.0	3.0	5.20	10608
	844.0	4.0	8.00	16320
	845.0	5.0	11.18	22807
	848.0	8.0	22.63	46165
	850.0	10.0	31.62	64505
{	855.0	15.0	58.09	117109
	860.0	20.0	89.44	180311

↳ $C = 3.2$, $L = 630$, $CL = 2016$

2. DETERMINE DISCHARGE THROUGH OUTLET WORKS.

(MAXIMUM DISCHARGE @ EL. 840 = 890 MILLION GALLONS/DAY
= 1377 cfs.

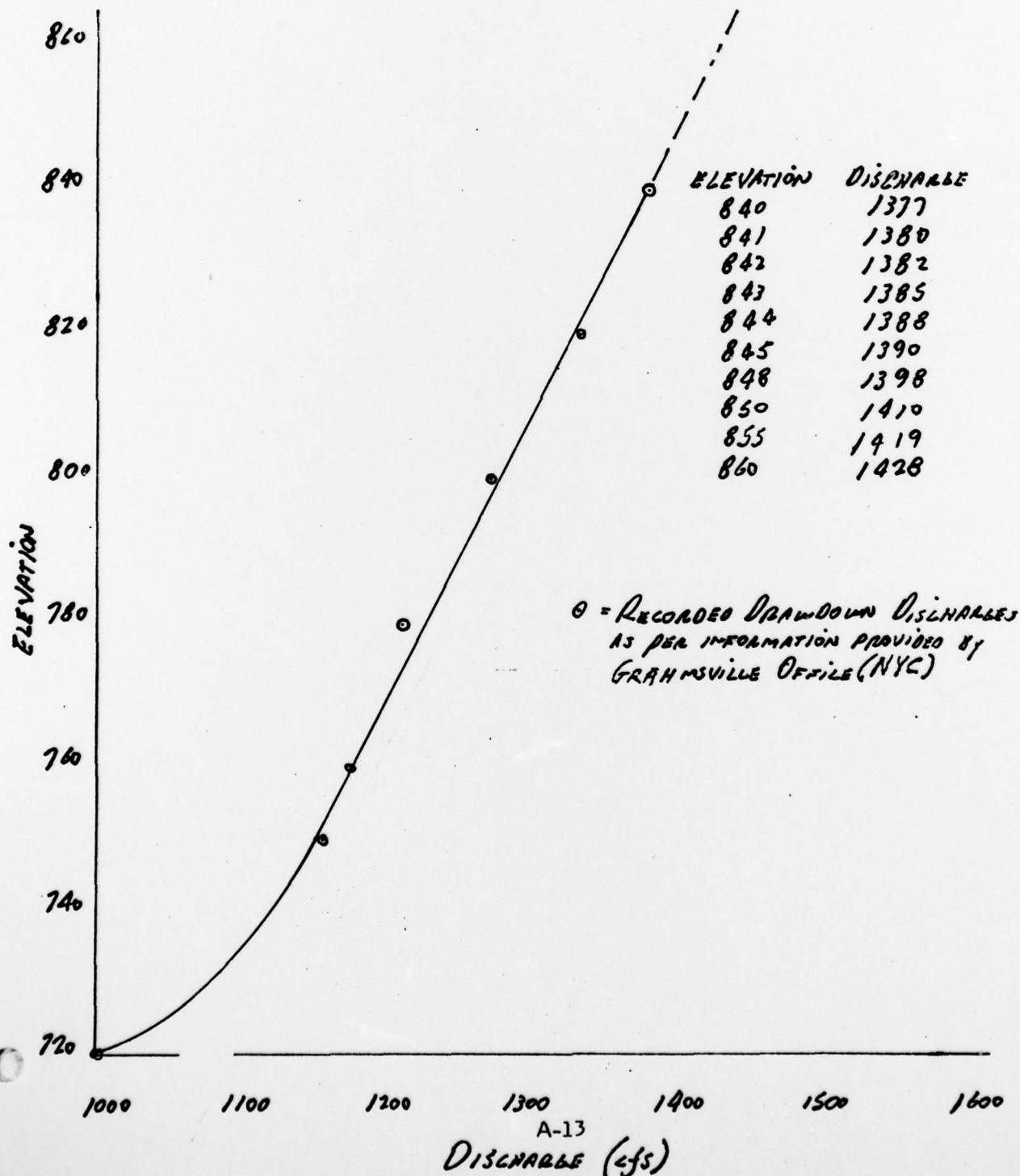
DISCHARGE @ EL. 720 (OVERFLOW WEIR) = 700 MILLION GALLONS/DAY
= 1083 cfs.

STRAIGHT LINE RELATIONSHIP FROM EL. 8.40 TO EL. 720

→ THIS INFORMATION PROVIDED BY MR. KEVIN CLOONAN
GRAHAMSVILLE, N. Y., 12740
POB 94

CHECKED BY DBc

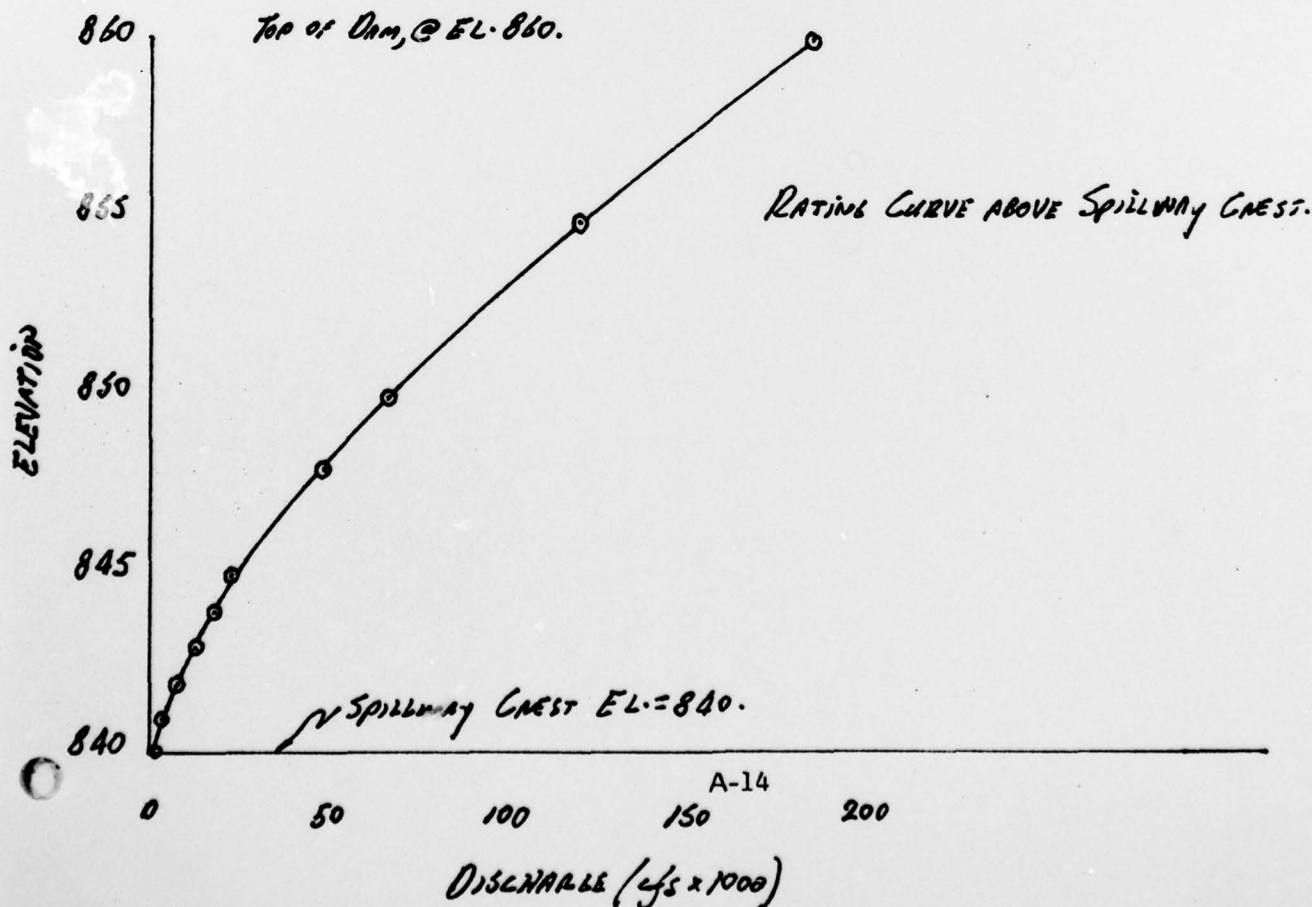
PROJECT MERRIMAN DAM



CHECKED BY DBC

PROJECT

Meridian Dam



SHEET No. 4 OF

SHEET No. 4 OF

DATE 7/6/78

COMP. BY FEF.

CHECKED BY DAC

NAME OF CLIENT _____

PROJECT MERRIMAN DAM

STAGE-STORAGE RELATIONSHIP

AREA @ 840, SPILLWAY CREST = 3.25 SQ. MI. = 2080 ACRES.

AREA @ 860, TOP OF DAM = 3.57 SQ. MI = 2285 ACRES.

$$(2285-2080)/20' = 205/20 = 10.25 \approx 10 \text{ ADRES/FT.}$$

$$AREA = 10 DEPTH + 2080$$

$$\text{STORAGE: } \int 10D + 2080 = 5D^2 + 2080D$$

ELEVATION	DEPTH	SD ²	2080 D	STANDARD
840.0	0	0	0	0
840.5	0.5	1.25	1040.0	1041
841.0	1.0	5.0	2080.0	2085
842.0	2.0	20.0	4160.0	4180
843.0	3.0	45.0	6240.0	6285
844.0	4.0	80.0	8320.0	8400
845.0	5.0	125.0	10400.0	10525
848.0	8.0	320.0	16640.0	16960
850.0	10.0	500.0	20800.0	21300
855.0	15.0	1125.0	31200.0	32325
860.0	20.0	2000.0	41600.0	43600

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Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET No. 5 OF

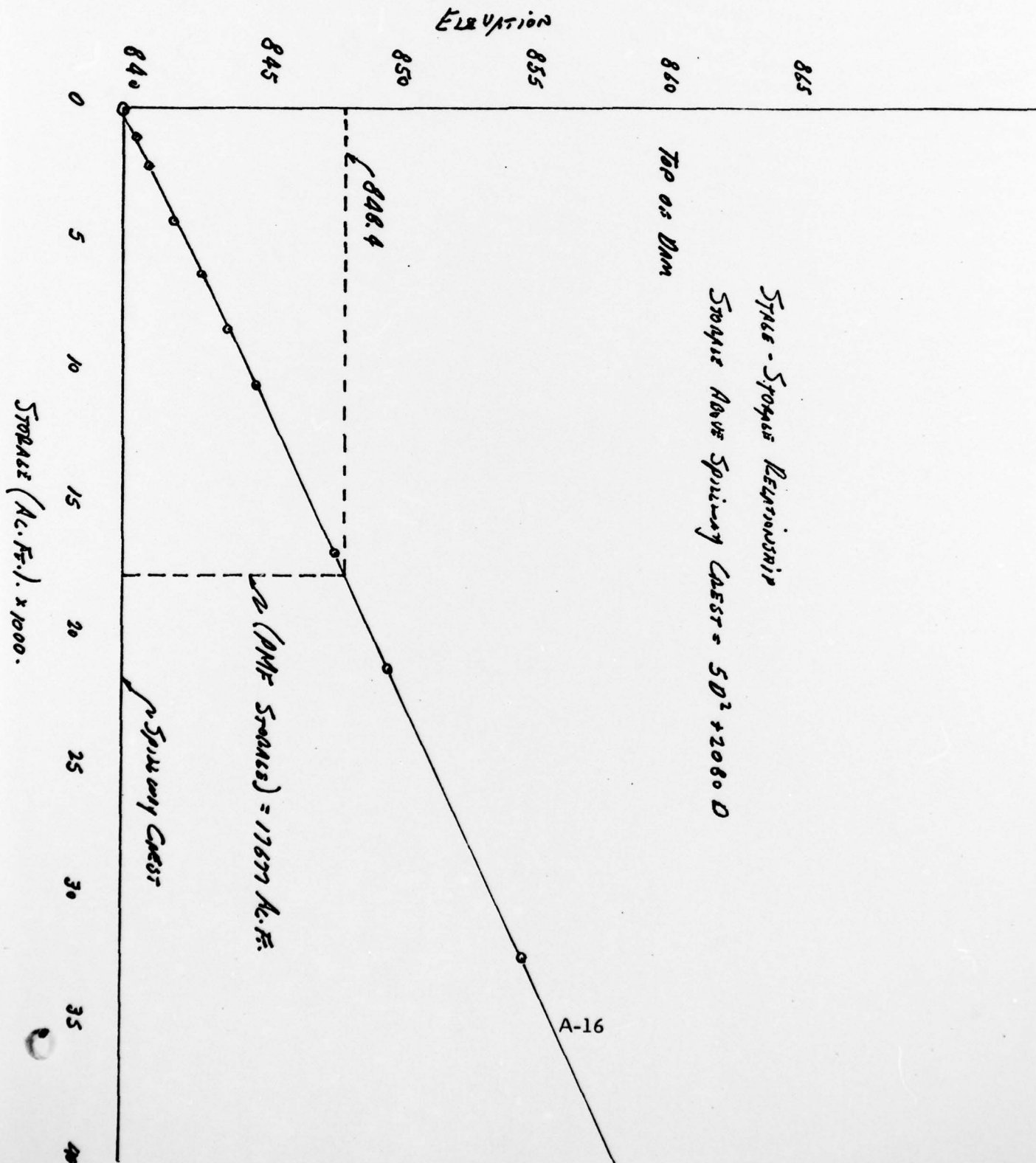
DATE 2/6/78

COMP. BY FBF

CHECKED BY DRC

NAME OF CLIENT_____

PROJECT MERZIMAN DAM



SHEET No. 6 OF

DATE 7/7/78

COMP. BY FEF

CHECKED BY DBC

NAME OF CLIENT _____

PROJECT MERRIMAN DAM

DRAINAGE AREA = 95 sq. mi. PMP = 23"

PMP in Zone #1 - 75% of 10 sq miles, 6 hour values

ISOHYETAL FIT REDUCTION FACTOR = 13.0%

CAR. ADJUSTED PMP = $23'' \times .13 = 2.99$

$$\text{REDUCTION} = 23 - 2.99 = 20.01$$

$$20.01 \times .75 = 15.01, \text{ USE } 15 \text{ INCHES.}$$

12 Hr PMP = $20.01 \times .84 = 16.8$ INCHES.

$$C_T = 2.0$$
$$C_p = .625$$

$L = 11.80$ MILES
 $L_{cp} = 2.0$ MILES

$$T_p = C_T (L \times L_{CA})^{0.2}$$

$$= 2.0 (11.8 \times 2.0)^{0.2} = 516$$

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SHEET NO. 7 OF
DATE 8/15/78
COMP. BY D3C
CHECKED BY REH

NAME OF CLIENT NYSDEC
PROJECT Merriman Dam

$$T_R = T_P / S.S = .94 \approx 1.0$$

USE 12 HOUR STORM

Time (hours)	Rainfall	
	Σ	Incr
0-1	.20	.20
1-2	.40	.20
2-3	.80	.40
3-4	1.20	.40
4-5	2.25	1.05
5-6	3.45	1.20
6-7	10.80	7.35
7-8	13.20	2.40
8-9	14.70	1.50
9-10	16.20	1.50
10-11	16.80	.30
11-12	16.80	.30

Use minimum loss rate of .1 inch/hour

SHEET No. 8 OF

DATE 7/25/78

COMP. BY *FEF*

CHECKED BY **DBC**

CHECKED BY DBC

NAME OF CLIENT _____

PROJECT

MERRIMAN DAM

DRAWDOWN COMPUTATIONS

Drawdown Time = 69 days

$A_1 = \text{AREA AT EL. 840}$

$S_1 = \text{STORAGE AT EL. 840} = 154000 \text{ ACRES FT.}$

$A_2 =$ AREA AT EL. 720

525 STORAGE AT EL. 720 = 7300 ACRES FT.

D = DEPTH.

$$(A_1 + A_2)/2 \times D = S_1 - S_2$$

$$(2080 + A_2)/2 = (154000 - 7300)/0$$

$$2080 + A_2 = 2(154000 - 7300)/120$$

$A_2 = 2445 - 2080$

$$A_2 = 365 \text{ АСМЕ}$$

$$R_{15E} = (2080 - 365) / 120' = 14.3 \text{ ACRES/FR.}$$

$$A_{\text{REA}} = 14.30 + A_2$$

$$\text{AREA} = 1430 + 365$$

$$STORAGE = 7.15 D^2 + 365 D$$

SEE SHEET #9

ELEVATION ⁺	DISCHARGE (CFS)	FROM/TO (ELEVATION)	INCREMENT (STORAGE)	TIME (HRS.)	TIME (DAYS)
840	1187	840/830	20095	205	8.54
820	1140	830/810	35900	381	15.88
800	1077	810/790	30180	339	14.13
780	1020	790/770	24460	290	12.08
760	987	770/760	10085	124	5.17
750	967	760/720	26040	326	13.58
720	0				

A-19

TOTAL TIME = 69 DAYS.

* ACCOUNTS FOR 2 cfs / sq mi DRAINAGE AREA AS INFLOW

$$2NF_{LOW} = 2 \times 95 = 190 \text{ cfs.}$$

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Division of O'Brien & Gere Engineers, Inc.
PHILADELPHIA, PA

SHEET No. 9 OF

DATE 7/25/78

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PROJECT.

$$\text{STORAGE} = 7.15 D^2 + 365 D$$

ELEVATION	DEPTH (FT.)	715 D ²	365 D	STORAGE (AC-FT.)	INCREMENT STORAGE
840	120	102 960	43800	146 760	20 095
830	110	86515	40 150	126 665	35900
810	90	57915	32850	90765	30180
790	70	35035	25550	60585	24460
770	50	17875	18250	36125	10085
760	40	11440	14600	26040	26040
720	0	0	0		

 HEC-1 VERSION DATED JAN-1973
 UPDATED AUG 74
 CHANGE NO. 01

MERRIMAN DAM
 PMF HYDROLOGY
 NATIONAL DAM INSPECTION PROGRAM

JOB SPECIFICATION
 NO NMR MAIN INAY IMR IMIN METRG IPLT IPRT INSTAN
 68 1 0 1 0 0 0 0 0 0
 JOPEX NMT
 3 0

SUR-AREA RUNOFF COMPUTATION

ISTAQ ICOMP IECON ITAPE JPLT JPRY INAME
 1 0 0 0 0 0 0

HYDROGRAPH DATA
 IYNG IJNG TAREA SNAP TRSDA TRSPC RATIO ISNOW ISAME LOCAL
 0 1 95.00 0.00 0.00 0.00 0.00 0 0 0

PRECIP DATA
 NP STORM DAIJ DAK
 12 0.00 0.00 0.00

PRECIP PATTERN
 .20 .20 .40 1.05 1.20 7.35 2.40 1.50 1.50
 .30 .30

LOSS DATA

STKRR DLYR RTIOL ERAIN STKRS RTIOL STPIL CNSTL ALSMX RTIMP
 0.00 0.00 1.00 0.00 0.00 1.00 0.00 .10 0.00 0.00

UNIT HYDROGRAPH DATA

TP= 5.16 CP= .63 NTA= 0

RECESSION DATA

STATQ= 0.00 TPCSN= 0.00 RTIOR= 1.00
 APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE IC= 6.06 AND R= 4.61 INTERVALS

UNIT HYDROGRAPH 28 END-OF-PERIOD ORIGINATES, LAG= 5.14 HOURS, CP= .63 VOL= 1.00
 56A. 2062. 4040. 5954. 7210. 7474. 6635. 5146. 4301. 3459.
 2783. 1801. 1448. 1155. 937. 754. 606. 444. 392.
 315. 204. 164. 132. 105. 96. 69.

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1 1 0	.20	.10	57.
1 2 0	.20	.10	263.
1 3 0	.40	.10	780.
1 4 0	.40	.10	1788.
1 5 0	1.05	.95	3686.
1 6 0	1.20	1.10	7043.

1 11	0	0.30	-20	92667.
1 12	0	0.30	-20	100494.
1 13	0	0.00	0.00	97188.
1 14	0	0.00	0.00	96427.
1 15	0	0.00	0.00	73784.
1 16	0	0.00	0.00	61056.
1 17	0	0.00	0.00	49545.
1 18	0	0.00	0.00	40013.
1 19	0	0.00	0.00	32188.
1 20	0	0.00	0.00	25892.
1 21	0	0.00	0.00	20827.
1 22	0	0.00	0.00	16753.
1 23	0	0.00	0.00	13476.
2 0	0	0.00	0.00	10940.
2 1	0	0.00	0.00	8720.
2 2	0	0.00	0.00	7014.
2 3	0	0.00	0.00	5642.
2 4	0	0.00	0.00	4538.
2 5	0	0.00	0.00	3645.
2 6	0	0.00	0.00	2927.
2 7	0	0.00	0.00	2338.
2 8	0	0.00	0.00	1864.
2 9	0	0.00	0.00	1447.
2 10	0	0.00	0.00	1103.
2 11	0	0.00	0.00	686.
2 12	0	0.00	0.00	264.
2 13	0	0.00	0.00	135.
2 14	0	0.00	0.00	31.
2 15	0	0.00	0.00	14.
2 16	0	0.00	0.00	0.
2 17	0	0.00	0.00	0.
2 18	0	0.00	0.00	0.
2 19	0	0.00	0.00	0.
2 20	0	0.00	0.00	0.
2 21	0	0.00	0.00	0.
2 22	0	0.00	0.00	0.
2 23	0	0.00	0.00	0.
3 0	0	0.00	0.00	0.

SUM 16.80 15.60 951479.

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
100494.	87684.	38931.	19822.	951479.
2FS	8.59	15.25	15.53	15.53
INCHES	43502.	77258.	78675.	78675.
AC-FT				

HYDROGRAPH ROUTING			
ISTAO	ICOMP	IECON	ITAPP
2	1	0	0
ROUTING DATA			
QLOSS	CLOSS	AVG	IRFS
0.0	0.000	0.00	1
NSIPS	NSIOL	LAG	AMSKK
0	0	J	0.000
X	ISK	STOPA	-1.

STORAGE=	0.	2085.	4180.	6285.	8400.	10525.	16960.	32325.	43609.
OUTFLOW=	0.	3420.	7155.	11993.	17709.	24197.	47561.	118528.	181739.

1	3	0	78.	522.	127.
1	4	0	167.	1284.	274.
1	5	0	358.	2737.	587.
1	6	0	728.	5368.	1194.
1	7	0	1511.	11315.	2479.
1	8	0	3153.	23768.	5324.
1	9	0	5993.	42669.	11322.
1	10	0	9930.	64081.	179.
1	11	0	14378.	84104.	3186.
1	12	0	19540.	96580.	54244.
1	13	0	21670.	98841.	67683.
1	14	0	23336.	91808.	75630.
1	15	0	23645.	90106.	77104.
1	16	0	22976.	67420.	73914.
1	17	0	21693.	55321.	67789.
1	18	0	20083.	44793.	60768.
1	19	0	18347.	36100.	53430.
1	20	0	16624.	29040.	46345.
1	21	0	14973.	23359.	40347.
1	22	0	13424.	18790.	34722.
1	23	0	12015.	15115.	29686.
2	0	0	10761.	12159.	25053.
2	1	0	9645.	9780.	21510.
2	2	0	8644.	7867.	18452.
2	3	0	7746.	6328.	15940.
2	4	0	6939.	5090.	13760.
2	5	0	6219.	4092.	11842.
2	6	0	5573.	3286.	10358.
2	7	0	4930.	2632.	9018.
2	8	0	4468.	2101.	7818.
2	9	0	4000.	1655.	6434.
2	10	0	3572.	1275.	5071.
2	11	0	3166.	794.	5447.
2	12	0	2783.	375.	4564.
2	13	0	2439.	199.	4052.
2	14	0	2134.	83.	3507.
2	15	0	1864.	22.	3058.
2	16	0	1628.	7.	2671.
2	17	0	1421.	0.	2332.
2	18	0	1241.	0.	2036.
2	19	0	1083.	0.	1777.
2	20	0	946.	0.	1552.
2	21	0	826.	0.	1355.
2	22	0	721.	0.	1183.
2	23	0	629.	0.	1032.
3	0	0	550.	0.	901.

945698.

2FS INCHES AC-FI	PEAK 77104.	SUM	6-HOUR 70681. 6.90 34967.	24-HOUR 36967. 14.48 73362.	72-HOUR 19702. 15.43 78197.	TOTAL VOLUME 945698. 15.43 78197.
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RUNOFF SUMMARY, AVERAGE FLOW						
HYDROGRAPH AT ROUTED TO		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
1	100434.	7694.	38931.	19822.	95.00	
2	77104.	70481.	36967.	19702.	95.00	